

Original Research Article

Seroprevalence and associated risk factors of leptospirosis among slaughtered cattle and abattoir workers at the Ngaoundéré municipal abattoir, Adamawa region, Cameroon.

Comment [J1]: Reduce length of title .

ABSTRACT

Aims: This study aims to determine the seroprevalence and risk factors of leptospirosis in slaughtered cattle and abattoir workers at the Ngaoundéré Municipal Abattoir as well as the knowledge, attitude and practice (KAP) assessment of the abattoir personnel with regards to the disease.

Comment [J2]: Not stated in title.consider delete. Use past tense. Revise abstract to conform to journal style

Study Design: 10% of the average number of cattle slaughtered in the abattoir within the one month visitation period was randomly chosen and evaluated. And 96 of 108 human sera were randomly selected and screened for the presence of anti-*Leptospira* spp antibodies.

Place and Duration of Study: Municipal abattoir Ngaoundéré and laboratories of IRAD-Wakwa Ngaoundéré, Cameroon, between March and June 2018.

Methodology: A total of 172 bovine and 96 human serum samples were screened for the detection of *Leptospira* spp antibodies by Lepto ELISA kit. Structured questionnaires were used to collect data on socio-demographics and risk-factors.

Results: The results showed that 18.02% (95% CI (4.7 – 33.34)) of the animals slaughtered were seropositive to *Leptospira* spp *hardjo* antibody. Though sex did seem to influence ($P > .05$) leptospira seropositivity, age and body condition score were major ($P = .05$) risk factors. A seroprevalence of 10.42% CI (4.30-16.52) was observed among the abattoir personnel with the

use of personal protective equipment such as gloves significantly ($P= .05$) influencing seropositivity.

Conclusion: Antibodies against *Leptospira* are prevalent among slaughtered cattle and workers in the Ngaoundéré municipal abattoir. This study reports the first evidence of human leptospirosis in Cameroon revealing real public health concern in the country. Public awareness campaigns and health education especially in agropastoral communities based on the One Health approach is essential to disseminate knowledge, associated risk factors and control measures of this occupational disease in Cameroon.

Keywords: *Bovine, Humans, Leptospirosis, Prevalence, Risk factors, Ngaoundéré abattoir-Cameroon*

1. INTRODUCTION

Leptospirosis is one of the most common and widespread bacterial zoonotic infection of economic importance worldwide [1] caused by infection with a pathogenic serovar of *Leptospira* spp. **bacteria** [2]. In humans, it can cause a wide range of symptoms, some of which may be mistaken for other diseases and most cases go undiagnosed and untreated leading to considerable suffering to the affected. Nevertheless, some infected individuals may be asymptomatic [3].

Many aspects of this neglected tropical and zoonotic disease is poorly understood in part because of **difficulty** in diagnosis, complexity of the host-leptospire relationship, changing patterns of infection, and lack of diagnostic laboratory services [4, 5]. Leptospirosis has not been widely studied in Africa [6], and in Cameroon, the last focus of the disease in humans was described in 1976 when an epidemic caused 95 cases, including 63 serologically confirmed cases, within two years [7]. Nevertheless, it is worth noting that the first leptospirosis epidemic in Cameroon occurred in 1975 which was initially misdiagnosed as a yellow fever epidemic [8].

Comment [J3]: Consider delete

Comment [J4]: Problem is due lack of diagnostic laboratory service

In bovine, leptospirosis is noted for the “milk drop syndrome” which occurs in serovar Hardjo-infected lactating cows [9] and enough loss due to abortions and infertility. Despite its global importance, large gaps persist in the understanding of the burden and epidemiology of leptospirosis in Africa [10]. However, Leptospirosis has been classed 12th of 41 major and priority zoonotic infections in Cameroon [11]. The prioritization was based on wide range of criteria including; the state of the disease in humans, domestic animals or wildlife in Cameroon; mortality, morbidity and disability in humans; the potential to spread rapidly amongst animals and human; economic, environmental and social impacts; and capacity for detection, prevention and control of the zoonosis in the country [11].

Comment [J5]: omission

Comment [J6]: criteria for disease prioritisation not relevant. Consider delete

Although reported seroprevalence data demonstrates widespread exposure to *Leptospira* spp. in humans and animals in Africa, little is known about the extent of the human disease and the epidemiology of *Leptospira* infection in different animal species in the continent [10]. There is dearth of information on leptospirosis in humans and scanty data of the diseases in cattle in Cameroon. A herd seroprevalence rate of 35% reported about a decade ago in the country [12] did not take into consideration infected animals in the food value chain and the public health concern of the disease. Thus, it is essential to investigate the epidemiology of bovine and human leptospirosis in Cameroon. In this context, this study was carried out to determine the prevalence and associated risk factors of leptospirosis in slaughtered cattle and personnel of the Ngaoundéré municipal abattoir Cameroon.

Comment [J7]: this statement is taken care of in next statement. Consider delete

2. MATERIAL AND METHODS

2.1 Study area

This study was carried out from March to June 2018 in the Ngaoundéré municipal abattoir of the Adamawa Region of Cameroon (7°- 8° N and 13°- 14°E) (Figure 1) where about 55 cattle are slaughtered daily (MINEPIA, 2018).

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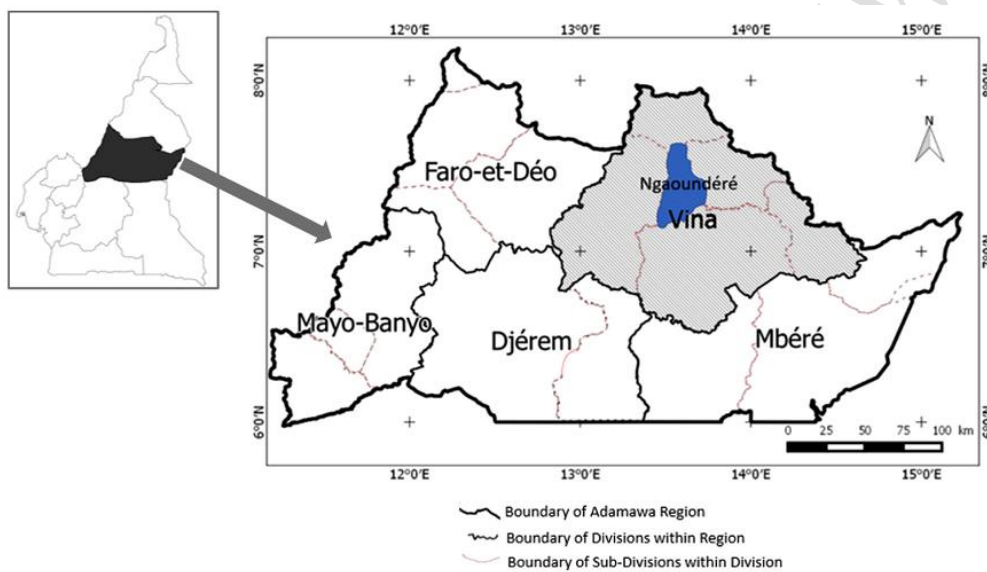


Figure 1: Map showing study area (Ngaoundéré) in Vina Division of the Adamawa Region in Cameroon. (Source: Ngaoundéré City Council for map of Adamawa Region, Cameroon. Map of Cameroon was adapted from Wikimedia Commons:

https://commons.wikimedia.org/wiki/Maps_of_Cameroon)

2.2 Selection of animals and blood sampling

About 20 % of the 40 – 60 cattle slaughtered daily in the abattoir randomly selected and sampled each day, uninterruptedly within a two-week period in the rain and dry seasons, were included in

Comment [J9]: Revise method for sampling animals for blood collection. Average number of samples per visit. Indicate total number of visits

the study. Based on a calculated sampling fraction of five (every fifth animal was sampled) for daily use, the first animal selected by picking one animal by random generation method of the first five animals on the slaughter chain. Thereafter, every fifth animal (adding 5 to previous picked number) was chosen till the sample size was achieved. Apart from procedural restraining manipulations for safety purposes, blood was collected from the jugular vein using VenojectND needle into sterile dry tubes. All samples collected were labelled, stored in ice pack container and carried to the Microbiology Research Laboratory of the Institute of Agricultural Research for Development (IRAD), Wakwa, Ngaoundéré, Cameroon, where they were centrifuged at 4000 rpm for 5 minutes, aliquoted into cryotubes, stored at -20 °C until serological analysis.

Comment [J10]: Indicate quantity of blood collected

2.3 Human sera samples

The human sera samples used for this investigation were originally collected from the same abattoir workers during the period of August 2015 to March 2016 in Ngaoundéré as part of a study of brucellosis at the Ngaoundéré Municipal Abattoir [13] and stored at -20°C. Briefly, 96 (representing the number of ELISA plate wells) of 108 human sera randomly selected by drawing out the cryotubes without replacement were screened for the presence of anti-*Leptospira* spp antibodies.

Comment [J11]: How can you justify risk factors, since the years are different. 2015-2016 human samples. March to June 2018. Animal samples. .infection status is not static

2.4 *Leptospira* ELISA analysis

2.4.1 Animal sample: The Linnodee Lepto Kit (Linnodee Animal Care, Ballyclare, UK) was used to screen the cattle sera for anti-*Leptospira hardjo* antibodies. This ELISA Kit is a double sandwich ELISA for the swift and safe detection of anti-*L. hardjo*-specific antibodies in serum with a sensitivity of 94.1% and specificity of 94.8%. The procedure was performed according to the manufacturer's instructions and essentially as described by Yan et al [14]

2.4.2 Human sample: The commercial Leptospira IgG (Lep IgG) ELISA Kit' (Schloss-Rahe-Str. 15, 52072 Aachen, Germany) was used to screen the human sera for anti-Leptospiral antibodies according to the manufacturer's instructions. Briefly, the test was conducted in 96-well polystyrene plate that was precoated with antigen. Anti-human-IgG, alkaline phosphatase was used as conjugate. After removal of excess conjugate by washing, an appropriate substrate (para-nitrophenylphosphate) was added, with which the conjugated enzyme reacted to produce a coloured derivative of the substrate. The colour intensity was proportional to the level of specific antibody bound and was quantified photometrically.

2.5 Data analysis

The data obtained were entered into Microsoft Office Excel 2013 to obtain descriptive statistics. Data analyses were done using SPSS Version 23. Variances and Chi square statistics were used to determine differences in significance at $P = .05$, and the association between potential risk factors and *Leptospira* infection.

Comment [J12]: Verify? $P < 0.05$

3. RESULTS

3.1 Prevalence of anti-*Leptospira spp* serovar hardjo antibodies in cattle

Overall, 31 of 172 tested bovine sera with sandwich ELISA were positive to anti-*Leptospira* serovar *Hardjo* antibodies corresponding to a prevalence of 18.02% [95% CI (12.28 – 23.76)].

3.2 Prevalence of leptospirosis with respect to the endogenous and exogenous factors

Overall 82.6% (142/172) of the cattle sampled were females whilst 17.4% (30/172) were males; and of these, 23 (74.2%) females and 8 (25.8%) males were seropositive. There was no significant difference in seropositivity between the sexes ($P = .175$). Of the seropositive animals, 5 (16.1%) were in the age group <4years, 20 (64.5%) in the age group 4-8 years and 6 (19.4%) in

Comment [J13]: Are exogenous and endogenous factors the same as risk factors?

Comment [J14]: State risk factors with no significant difference. Include all risk factors with significant differences in a single statement describe where applicable. Take note of p values. Place 0 before decimal point

Comment [J15]:

the age group >8years. There was a high significant difference in the seropositivity due to age ($P < .000063$).

Out of the 172 animals sampled, 131 (76.16%) registered a poor body condition score (BCS of 1 or 2) and 41 (23.83%) were average (BCS=3). Of these, 31 poor or emaciated animals were seropositive for anti-*Leptospira* antibody while all the average score animals were seronegative. There was a high significant difference ($P < .001$) in seropositivity due to BCS.

Out of the 172 animals sampled, 99 (57.55%) were of the Gudali breed, 39 (22.67%) White Fulani, 20 (11.63%) Red Fulani, 3 (1.74%) Bokolo, 3(1.74%) Bokolo-Charolais Hybrid and 8 (4.65%) Gudali-White Fulani hybrid. Of these, 17 (54.8%) Gudali, 11 (35.5%) White Fulani and 3(9.7%) Bokolo-Charolais hybrids were positive for anti-*Leptospira spp.* Serovar *Hardjo* antibodies. There was no significant difference ($P = .147$) in seropositivity due to breeds (Table 1).

Table 1. Seroprevalence of leptospirosis in cattle of the Ngaoundéré abattoir according to risk factors (N=172).

| Factors | Variables | Positive ELISA | N | Prevalence % (95% CI) | OR (95% CI) | P-value | χ^2 |
|---------|---------------------------|----------------|----|-----------------------|-------------|---------|----------|
| Breed | Bokolo | 0 | 3 | 0.0 | - | 0.147 | 2.11 |
| | Red Fulani | 0 | 20 | 0.0 | - | | |
| | Gudali*White Fulani cross | 0 | 8 | 0.0 | - | | |

| | | | | | | | |
|-----------------------------|-----------------------------|----|-----|---------------------|--------------------|-----------------------|--------|
| | Bokolo*Charolais cross | 3 | 3 | 100 | 587924071.5 | 0.175 | 1.837 |
| | White Fulani | 11 | 39 | 28.2 [14.08-42.32] | / | | |
| | Gudali | 17 | 99 | 17.7 [10.18-25.22] | 1.059(0.336-3.338) | | |
| Sex | Female | 23 | 142 | 16.2 [10.14-22.26] | 0.173(0.04-0.747) | 0.175 | 1.837 |
| | Male | 8 | 30 | 26.6 [4.93-52.27] | / | | |
| Age (Years) | Adult [$4 \leq x \leq 8$] | 6 | 88 | 6.8 [1.54-12.06] | 0.329(0.075-1.45) | 0.000063 ^a | 18.856 |
| | Old [$x > 8$] | 20 | 56 | 35.71 [23.16-48.26] | 2.50(0.55-11.34) | | |
| | Young [$x < 4$] | 5 | 28 | 17.85 [3.32-31.38] | / | | |
| Body Condition Score | Average (3) | 0 | 41 | 0.0 | - | 0.074 | 3.187 |
| | Poor (1 and 2) | 31 | 131 | 23.7 [16.42-30.98] | - | | |
| Season | Dry | 11 | 86 | 12.8 [10.05-26.35] | 0.760(0.250-2.313) | 0.074 | 3.187 |
| | Rainy | 20 | 86 | 23.25 [14.32-32.18] | / | | |
| Origin of animals | Vina | 20 | 110 | 18.2 [10.9-25.41] | - | 0.943 | 0.005 |
| | Mayo Rey | 11 | 62 | 17.8 [8.28-27.32] | - | | |

Comment [J16]: Where from that? Its significance.

N=number of animals; BCS=body condition score (Significant if $P = .05$)

Comment [J17]: $P < 0.05$

Table 1 also presents the seroprevalence of bovine leptospirosis according to exogenous factors.

Comment [J18]: Revise statement and use it to start 3.2

Overall, 62 (36.04%) animals were from Mayo Rey Administrative division in the North Region and 110 (63.95%) animals from Vina Administrative division of the Adamawa Region were used in the study. Also, *Leptospira* seropositive reactions were observed in 11 (35.5%) cattle from

Mayo Rey and 20 (64.5%) from Vina. There was no significant difference ($P= .9$) for seropositivity due to origins of the slaughtered cattle.

As for season, 86 (50%) cattle were sampled during the dry and 86 (50%) during the rainy season. Of these, 11 (12.8%) animals in the dry season and 20 (23.25%) in the rainy season were seropositive for anti-*Leptospira spp* serovar *hardjo* antibodies. However, there was no significant difference ($P> .05$) due to season.

The influence of intrinsic risks factors (breed, sex, BCS and age) on the seroprevalence of Leptospirosis are presented in Table 1.

The White Fulani was more likely of getting leptospirosis compared to the Gudali though $OR<1$. Age was a significant risk factor with the animals in the old age group (>8 years) being more less and the young groups (<4 years) being more likely of getting bovine leptospirosis than the others

3.3 Prevalence of leptospirosis among abattoir workers

A total of 10 abattoir workers [10.41% CI (4.30-16.52)] were positive to anti-*Leptospira* IgG. Overall, 16 (16.66%) female and 80 (83.34%) male tested showed 4 (25.0%) females and 6(75%) males were seropositive for anti-*Leptospira* antibodies. The study showed that sex ($P= .06$) (Table 2) and age ($P= .187$) (Table 2) did not significantly affect *Leptospira* seropositivity. However, the use of personal protective wares such as gloves significantly influences ($P< .001$) *Leptospira* seropositivity amongst abattoir workers (Table 3).

Table 2. Seroprevalence of leptospirosis in abattoir workers in Ngaoundéré according to potential risk factor (N=96)

| Category | Variable | Total | Positive ELISA | 95%CI of positive | OR (95% CI) | P-value (χ^2) |
|----------|----------|-------|----------------|-------------------|-------------|----------------------|
|----------|----------|-------|----------------|-------------------|-------------|----------------------|

Comment [J19]: Start with a statement on results of seroprevalence in abattoir workers presented in Table 2.

Comment [J20]: Check p value

Comment [J21]: Differentiate between Table 2 and Table 3. Table 2: intrinsic risk factors

Comment [J22]: Check spelling

| | | N (%) | | | | |
|-----|---------|----------------|------------|--------------|---------------------|------------------|
| Sex | Female | 16 | 4 (25.0%) | [3.78-46.22] | 4.111(1.009-16.747) | 0.06 (5.987) |
| | Male | 80 | 6 (7.5%) | [1.73-13.27] | / | |
| | Total | 96 | 10 (10.4%) | [4.30-16.52] | - | |
| Age | [15-25[| 26 | 4 (15.4%) | [1.53-29.27] | 0.545[0.08-3.73] | 0.187 (4.447) |
| | [25-35[| 43 | 2 (4.7%) | [0-11.03] | 0.146[0.017-1.243] | |
| | [35-45[| 19 | 2 (10.5%) | [0-14.22] | 0.353[0.04-3.09] | |
| | [45-65] | 8 | 2 (25.0%) | [0-55.01] | / | |
| | Total | 96 (100.0%) | 10 (10.4%) | [4.30-16.52] | - | |

Significant if $p = .05$

Comment [J23]: Check p value

Table 3. Seroprevalence of leptospirosis in abattoir workers in Ngaoundéré with respect to potential risk factors (N=96)

Comment [J24]: Consider renaming Table 3: extrinsic risk factors.

| Variable | N | Positive ELISA N (%) | 95%CI of positive | OR (95% CI) | P-value |
|----------|---|-------------------------|----------------------|-------------|---------|
|----------|---|-------------------------|----------------------|-------------|---------|

Comment [J25]: Create column for χ^2

| | | | | | | |
|---|---------|----|------------|---------------|--------------------|----------|
| | <1year | 6 | 0 (0.0%) | - | | |
| | [1-5] | 32 | 4 (12.5%) | [2.42-22.58] | 0.90 (0.21 – 3.96) | |
| Longevity in service | [6-10] | 14 | 2 (14.3%) | [4.22-24.38] | 0.77 (0.13 – 4.80) | 0.962 |
| | [11-20] | 35 | 4 (11.4%) | [1.32-21.48] | / | (0.076) |
| | >20 | 9 | 0 (0.0%) | - | | |
| Use of personal protective equipment | No | 20 | 0 (0.0%) | - | | |
| | Yes | 76 | 10 (13.2%) | [3.12-23.28] | | |
| Use of hand gloves | No | 86 | 6 (7.0%) | [-3.08-17.08] | / | 0.001 |
| | Yes | 10 | 4 (40.0%) | [29.92-50.08] | 0.11 (0.02 – 0.51) | (10.469) |
| Boots and Water proof overalls | No | 22 | 2 (9.1%) | [-0.98-19.18] | / | 0.817 |
| | Yes | 74 | 8 (10.8%) | [0.72-20.88] | 0.83 (0.16 – 4.20) | (0.054) |
| Contact with aborted fetus | No | 76 | 8 (10.5%) | [0.42-20.58] | / | 0.945 |
| | Yes | 20 | 2 (10.0%) | [-0.08-20.08] | 1.06 (0.21 – 5.42) | (0.005) |
| Consumption of unpasteurized milk | No | 56 | 8 (14.3%) | [4.22-24.38] | 0.38 (0.08 – 1.89) | 0.142 |
| | Yes | 40 | 2 (5.0%) | [-8.08-12.08] | / | (2.156) |
| Consumption of poorly cooked meat | No | 22 | 0 (0.0%) | - | - | |
| | Yes | 74 | 10 (13.5%) | [3.42-23.58] | - | |

Significant if $P = .05$

Comment [J26]: Check p value

3.4 Association between Seroprevalence and risk factors in abattoir worker population.

As concerns the level of association between the observed prevalence in the worker population and identified risk factors ; it was noticed that there was a very strong association between the use of boots and waterproof overalls and the minimal use of personnel protective equipment (shoes, slippers etc.) with $R=0.941$. There equally existed a correlation between the sex and the longevity of service ($R=0.530$), the sex and the working post ($R=0.637$), the sex and the use of boots and waterproof overalls ($R=0.616$) and finally the sex and the use of personal protective equipment ($R=0.513$) (Table 4).

Table 4. Correlation variable for the level of association between different risk factors in abattoir workers

Comment [J27]: Please revise Table 4. The association is between seroprevalence in Leptospirosis and risk factors. The table does not depict that. Correlate seroprevalence to Age, Seroprevalence to sex, PPE use etc.

| | Age | Sex | Longevity of service | Working post | Use of PPE | Use of gloves, | Boots, waterproof overalls | Contact with aborted fetus | Consumption of poorly cooked meat | Consumption of unpasteurized milk |
|--|-----|-----|----------------------|--------------|------------|----------------|----------------------------|----------------------------|-----------------------------------|-----------------------------------|
|--|-----|-----|----------------------|--------------|------------|----------------|----------------------------|----------------------------|-----------------------------------|-----------------------------------|

| | | | | | | | | | | |
|--------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Age | 1.000 | .315 | .371 | .328 | .295 | .048 | .346 | .051 | -.075 | -.064 |
| Sex | .315 | 1.000 | .530 | .637 | .513 | .246 | .616 | .066 | .054 | .348 |
| Longevity of service | .371 | .530 | 1.000 | .426 | .425 | .107 | .448 | .144 | .334 | .213 |
| Working post | .328 | .637 | .426 | 1.000 | .469 | .223 | .537 | .208 | .316 | .422 |
| Use of Personal protective equipment | .295 | .513 | .425 | .469 | 1.000 | -.175 | .941 | .137 | .209 | .017 |
| Use of glove | .048 | .246 | .107 | .223 | -.175 | 1.000 | -.024 | .007 | -.186 | .288 |
| Boots and waterproof overalls | .346 | .616 | .448 | .537 | .941 | -.024 | 1.000 | .158 | .174 | .059 |
| Contact with aborted fetus | .051 | .066 | .144 | .208 | .137 | .007 | .158 | 1.000 | .280 | .191 |
| Consumption of poorly cooked meat | -.075 | .054 | .334 | .316 | .209 | -.186 | .174 | .280 | 1.000 | .059 |
| Consumption of unpasteurized milk | -.064 | .348 | .213 | .422 | .017 | .288 | .059 | .191 | .059 | 1.000 |
| Proper Value | 5.385 | 2.692 | 2.178 | 1.931 | .625 | .593 | .542 | .348 | .205 | .161 |

NB: Association if $R > 0.5$.

4. DISCUSSION

4.1 Bovine leptospirosis seroprevalence

The bovine leptospirosis seroprevalence recorded (18.02%) in the present study is higher than 3.5% obtained by Ngbede et al [15] in the Zango abattoir, Kaduna state, Nigeria but less than 35% recorded by Scolamacchia et al [12] in the Adamawa plateau of Cameroon. This difference

was associated with agro-ecological location, animal population and amount of sampled cattle per study. Similar leptospira seroprevalence in cattle were recorded in Dakar abattoir in Senegal (20.8%) [16] and KwaZulu-Natal, South Africa (19.4%) [17] though different diagnostic test methods were used.

The seroprevalence of the disease was non significantly higher in bulls than cows and agrees with the findings of Ngbede et al [15] (42.94% in cows and 57.04% in bulls) and Ramin et al [18] (10.9% in bulls and 4.8% in cows). The study revealed that age was a major risk factor which agrees with the findings of Ngbede et al [15] who reported higher seropositive reactors (35.71%) among animals aged more than 8 years compared to the other age groups in the Zango Abattoir Nigeria. This could be attributed to the duration of exposure and persistence of the antibodies in the aged animals to the pathogen [15]. This finding is in accordance with those reported in Iran and other countries where increase in leptospirosis seropositivity were observed in adult animals [19, 20]

Comment [J28]: Verify .significant difference or significantly higher

There existed no statistically significant difference ($P = .05$) in seropositivity between the different cattle breeds. These results concur with Ngbede and colleagues [15] who however reported a high prevalence in zebu breed of cattle based on origin of the cattle and not as a significant factor of *Leptospira* infection which is contrary to other reports [21, 22, 23]. Seroprevalence difference due to region or locality could be due to many factors including soil type, mean temperature, herd management practices and presence of wildlife. However, due to the heterogeneous nature of these breeds care should be cautioned not to over-interpret these findings [21].

Comment [J29]: P value

Body condition score was a major factor influencing leptospira seropositivity in this study with animal with poor BSC being most affected. Chronic leptospirosis are usually caused by host-

adapted *Leptospira* serovars and *Leptospira* serovar *hardjo* has been observed to cause several clinical manifestations amongst individual with poor growths [24]. However, animals with poor BCS are usually associated with malnutrition, compromised defense system and increased susceptibility to stress and higher risks of being infected. Also, high rates concomitant infections are widespread in livestock in poor African countries. These reasons could have been responsible for the higher seropositivity recorded among animals with poor BCS.

4.2 Human leptospirosis seroprevalence

The detection of anti-*Leptospira* spp. antibodies in the abattoir worker – slaughtered animal interface could indicate a continual source of human leptospires which poses problems to public health. The abattoir workers were at high risk of contraction the zoonoses owing to the fact that they were always in contact with live animals and animal products during the meat processing phase. The majority of leptospirosis cases usually show mild symptoms which do not often require medical intervention [10]. However, a diverse range of severe clinical manifestations including jaundice, aseptic meningitis, renal failure and rarely, lethal pulmonary hemorrhage and cardiac involvement, have been reported in infections with *Leptospira* spp. [25]. These non-specific symptoms make diagnosis of leptospirosis difficult [15] as well as reduce the level of awareness of the disease. The diagnoses of febrile illnesses are often limited to malaria and typhoid fever and presentation of jaundice to viral infection with complete neglect to spirochetes infections [26].

This study affirmed the presence of antibodies to human *Leptospira* in abattoir personnel with a seroprevalence of 10.4%. This result is similar to the 11% prevalence obtained by Dreyfus et al [27] in New Zealand but lower than 15.2% by Tabo et al [28] in the Philippines, 81% by Abiayi

et al [26] in Nigeria and 72.5% in Malaysia [29]. The observed differences could be associated to detection of antibodies against more than one serovar, infections by mixed serovar and cross-reactivity among serovars at different titres [26]. Sex, age and longevity in service were observed not to be significant risk factors *Leptospira* infection.

Although there was no statistical significance between the prevalence and the sex; there was however a high association between the sex and the duty post, years of working, use of boots and waterproof overalls and other Personal protective equipment(PPE). Several other studies have shown that there is an association between leptospirosis and gender [30]. Leal –Castellanos et al concluded in a study that the risk factors with the highest strength of association was occupational contact with animal excreta and this risk was higher if subjects had no protection against contact and the presence of cut/abrasion of the skin [31]. The above observed associations are an indication that preventive measures need to be implemented in order to curb the spread and dissemination of leptospirosis among this risk group.

The presence of *Leptospira*-agglutinating antibodies among abattoir workers was attributed to constant exposure of these workers to fluids of slaughtered animals and contaminated abattoir environment [28]. Also, minor cuts and injuries sustained during work in the abattoirs did not serve as deterrent from handling animal tissues, which may have been infected [26]. This explained the reason personal protective equipment such as the use of gloves was a major significant risk factor for seropositivity observed amongst the abattoir personnel in this study. Though butchers are usually unruly, minimum personal protective equipment requirements depicted by the veterinary services for butchers in the Ngaoundéré Municipal Abattoir include gloves, goggles, masks as well as waterproof jumpsuits, boots and jackets. Otherwise, they

would not be allowed access to the slaughterhouse until after inspection. Despite this minimum requirement, few butchers (37.7%) made use of waterproof overalls for extra protection.

5. CONCLUSION

Leptospirosis is a neglected debilitating zoonosis and an occupational hazard which is high seroprevalence in Cameroon. Transmission to humans at the animal-human interphase can occur through contact with infected animals and animal products. The study reports the first evidence of human leptospirosis in Cameroon and revealed that leptospira infection is an important public health problem among abattoir personnel in Ngaoundéré Cameroon. However, a bacteriological study of leptospirosis would be necessary to determine circulating serotypes in the Ngaoundéré area and beyond. Though cattle were leptospirosis seropositive irrespective of sex, body condition score, age and breed were the major factors observed to be associated with bovine leptospirosis. The risk of transmission to humans was aggravated by not using protective equipment at work and handling of carcasses. Public awareness campaigns and health education especially among livestock professional and in agropastoral communities should be highlighted to disseminate knowledge, associated risk factors and control measures of leptospirosis. The enlightenment should include encouraging animal professionals to consistently use full personal protective equipment and good personal hygiene practices at work, and adhering to safe animal-product handling practices. Serological surveillance of human leptospirosis and the associated risk factors is essential in Cameroon particularly among livestock professionals and in agropastoral communities. The need for intensification of the integrated “One Health” approach and multi-sectoral policies including interdisciplinary strategies between animal and human health experts, concerned target stakeholders and affected communities about the need for

Comment [J30]: This is not part of your study. Consider delete

Comment [J31]: Capture as a recommendation

Comment [J32]: State seroprevalence in cattle and humans. State risk factors identified. Provide recommendations to reduce incidence

detailed information on animal and human leptospirosis for effective management in the country cannot be overemphasized.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Permission for the study was obtained from the required authorities and Local Ethical Committees in Adamawa Region, Cameroon including the Regional delegation of Livestock, Fisheries and Animal Industries, Regional Delegation of Public Health, School of Veterinary Medicine and Sciences of the University of Ngaoundéré and Ngaoundéré Regional Hospital. The purpose of the study was explained (with the assistance of local veterinary and medical practitioners, community leaders and trusted intermediaries) to personnel at the Ngaoundéré abattoir. Cattle professional including butchers and personnel at the Ngaoundéré abattoir were used in the study after giving their written informed consent.

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